

Network Systems
Science & Advanced
Computing
Biocomplexity Institute
& Initiative
University of Virginia

Analysis of COVID-19 in Virginia

July 21th, 2021

(data current to July 18th – July 20th)

Biocomplexity Institute Technical report: TR 2021-079



BIOCOMPLEXITY INSTITUTE

biocomplexity.virginia.edu

About Us

- Biocomplexity Institute at the University of Virginia
 - Using big data and simulations to understand massively interactive systems and solve societal problems
- Over 20 years of crafting and analyzing infectious disease models
 - Pandemic response for Influenza, Ebola, Zika, and others



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Overview

- **Goal:** Evaluate indicators of change to guide future analyses and simulations
- **Approach:**
 - Visualizations of existing data
 - Statistical analyses to test hypotheses
 - Synthesis of multiple data sources and interpretation
- **Outcomes:**
 - Inform future analytic and simulation based studies
 - Improve awareness of evolving trends and novel elements
 - Foster discussion

Key Takeaways

Projecting future cases precisely is impossible and unnecessary.

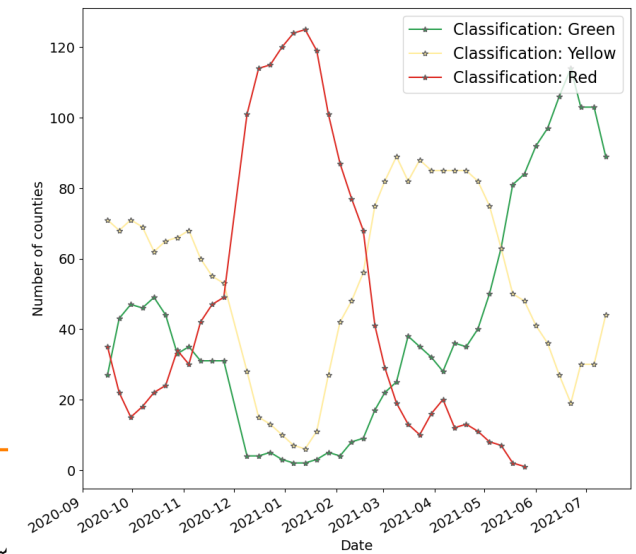
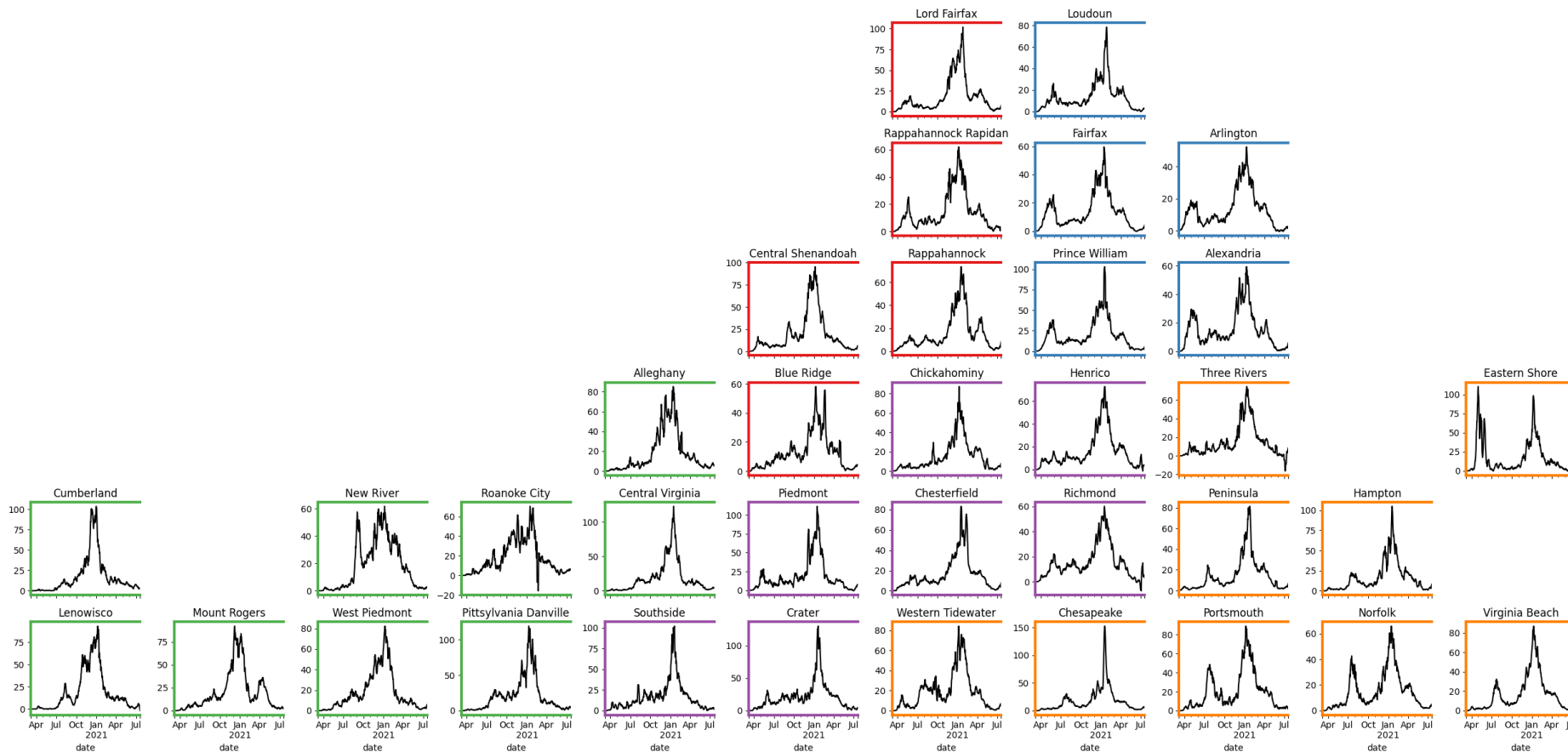
Even without perfect projections, we can confidently draw conclusions:

- **Case rates in Virginia have risen more broadly, some districts with rapid growth return to high case rates**
- VA mean weekly incidence slightly up to 4.4/100K from 2.8/100K, US up to 10/100K (from 7.2/100K)
- Vaccination rates continue to be slow while measured acceptance among unvaccinated remains steady
- Delta variant continues to grow, causing surges in several states and increased hospitalizations

The situation continues to change. Models continue to be updated regularly.

Situation Assessment

Case Rates (per 100k) and Test Positivity



<https://data.cms.gov/stories/s/q5r5-gjyu>

County level test positivity from RT-PCR tests.

Green: <5.0%

(or with <20 tests in past 14 days)

Yellow: 5.0%-10.0%

(or with <500 tests and <2000 tests/100k and >10% positivity over 14 days)

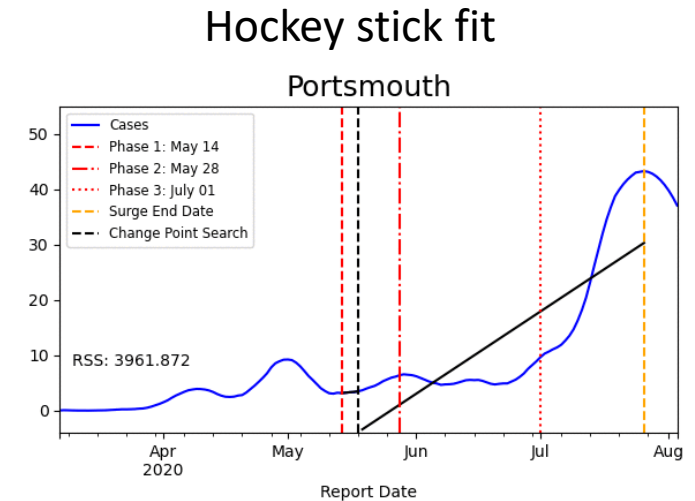
Red: >10.0%

(and not "Green" or "Yellow")

District Trajectories

Goal: Define epochs of a Health District's COVID-19 incidence to characterize the current trajectory

Method: Find recent peak and use hockey stick fit to find inflection point afterwards, then use this period's slope to define the trajectory

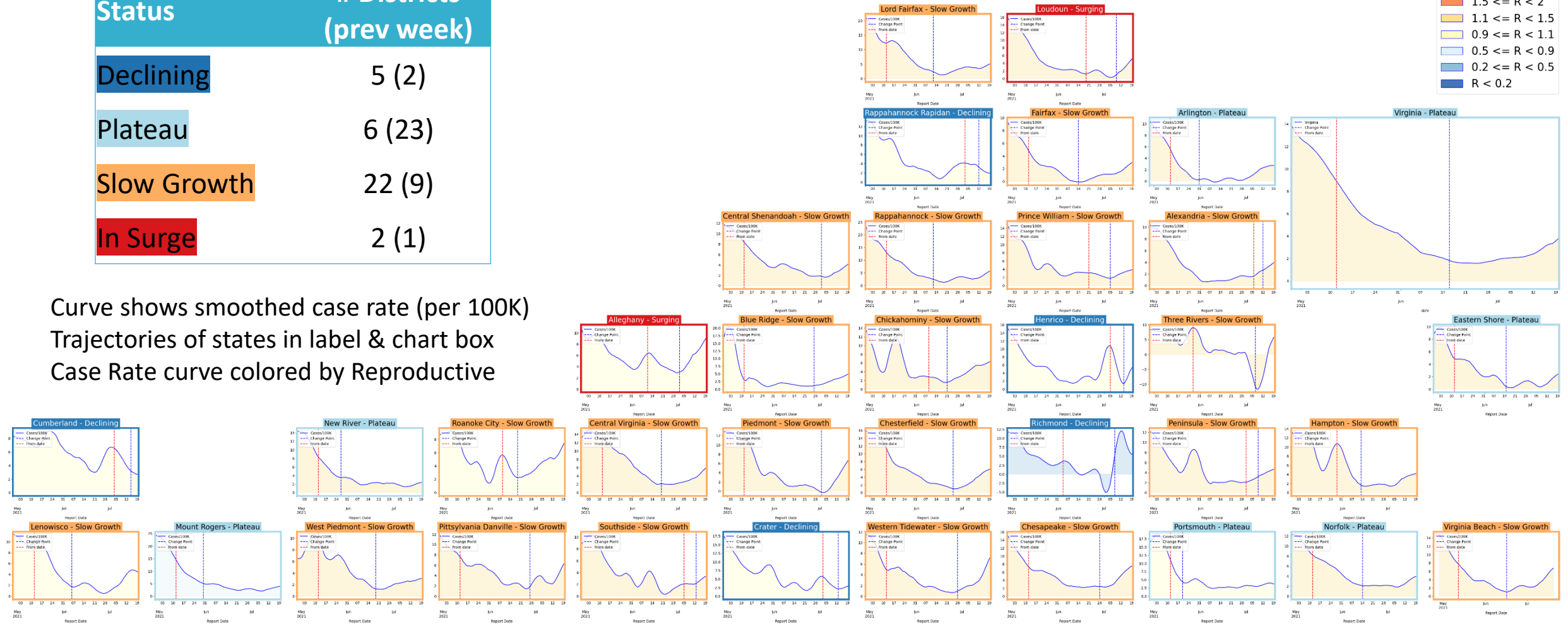


Trajectory	Description	Weekly Case Rate (per 100K) bounds	# Districts (prev week)
Declining	Sustained decreases following a recent peak	below -0.9	5 (2)
Plateau	Steady level with minimal trend up or down	above -0.9 and below 0.5	6 (23)
Slow Growth	Sustained growth not rapid enough to be considered a Surge	above 0.5 and below 2.5	22 (9)
In Surge	Currently experiencing sustained rapid and significant growth	2.5 or greater	2 (1)

District Trajectories – last 10 weeks

Status	# Districts (prev week)
Declining	5 (2)
Plateau	6 (23)
Slow Growth	22 (9)
In Surge	2 (1)

Curve shows smoothed case rate (per 100K)
Trajectories of states in label & chart box
Case Rate curve colored by Reproductive



Estimating Daily Reproductive Number

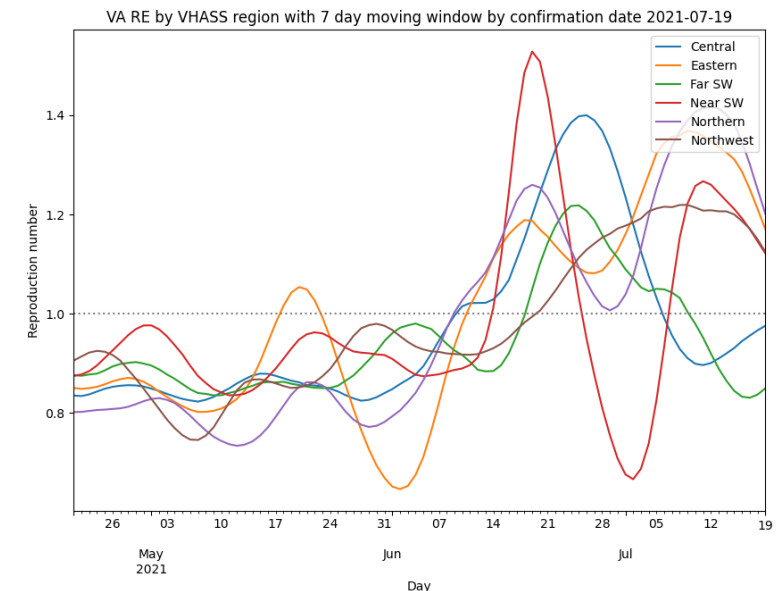
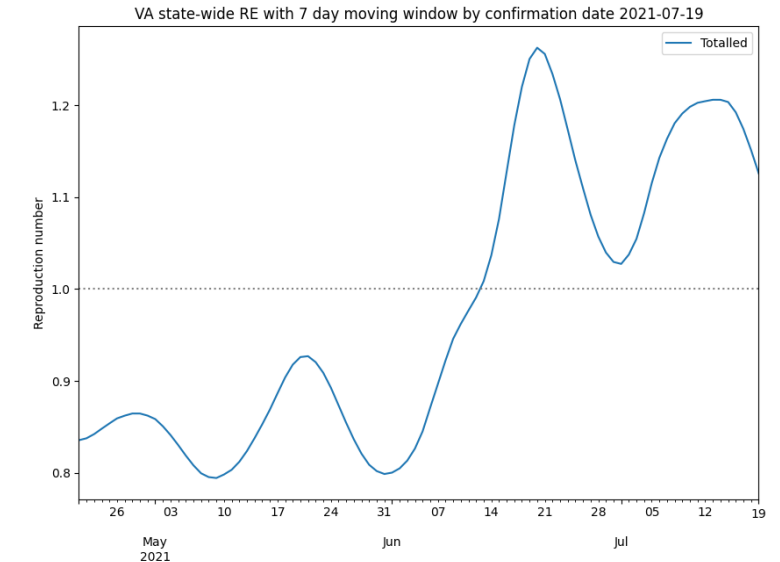
July 20th Estimates

Region	Date Confirmed R_e	Date Confirmed Diff Last Week
State-wide	1.175	0.128
Central	1.105	0.178
Eastern	1.167	0.051
Far SW	0.989	-0.013
Near SW	1.248	0.248
Northern	1.201	0.043
Northwest	1.167	0.092

Methodology

- Wallinga-Teunis method (EpiEstim¹) for cases by confirmation date
- Serial interval: updated to discrete distribution from observations (mean=4.3, Flaxman et al, Nature 2020)
- Using Confirmation date since due to increasingly unstable estimates from onset date due to backfill

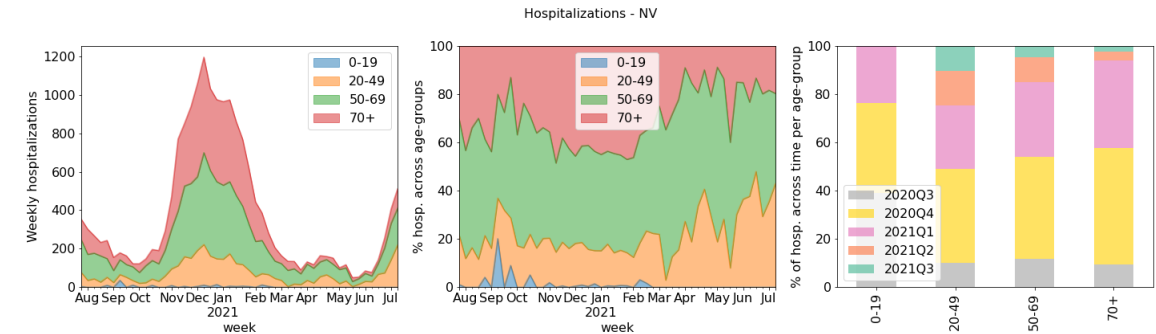
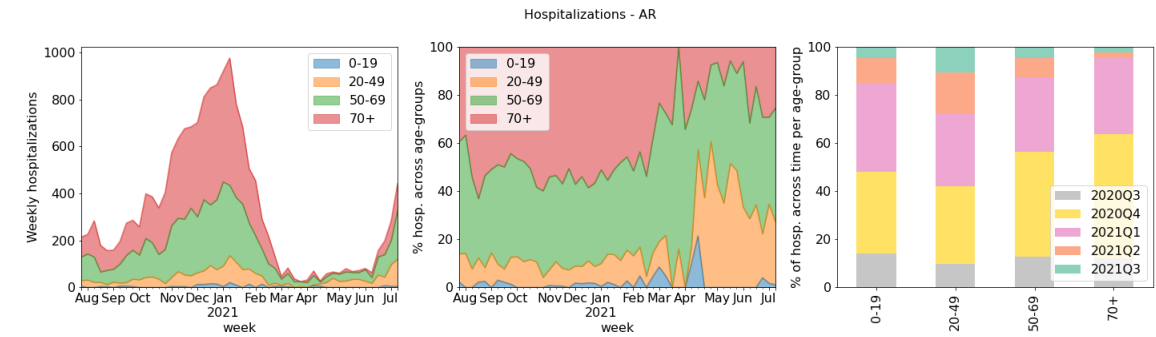
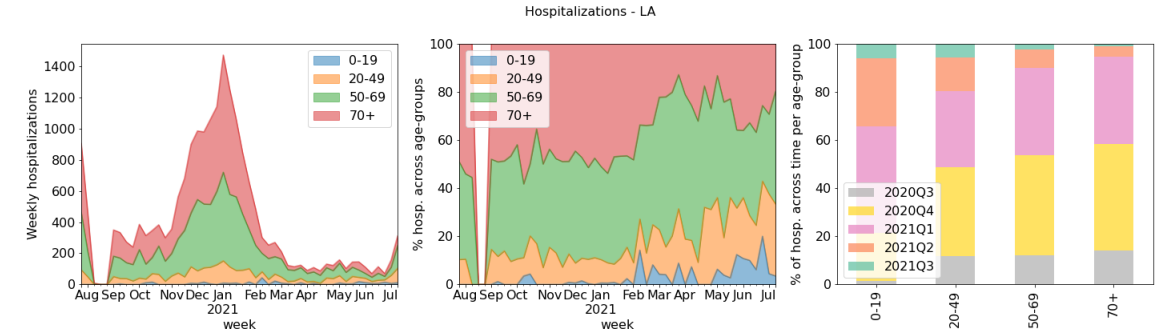
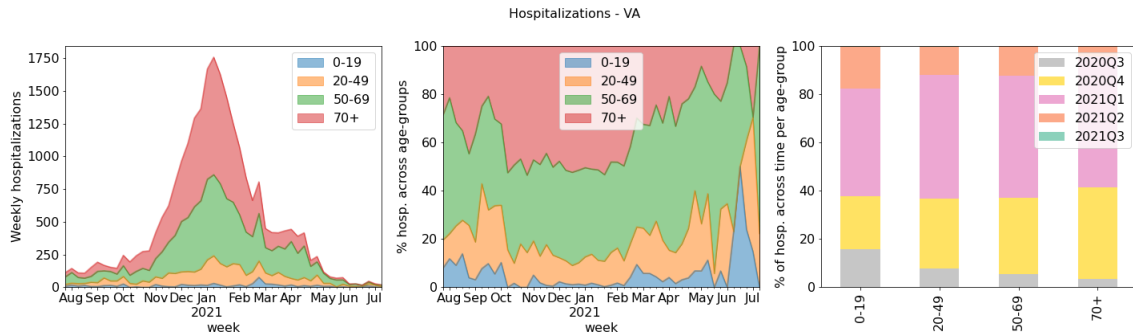
1. Anne Cori, Neil M. Ferguson, Christophe Fraser, Simon Cauchemez. A New Framework and Software to Estimate Time-Varying Reproduction Numbers During Epidemics. American Journal of Epidemiology, Volume 178, Issue 9, 1 November 2013, Pages 1505–1512, <https://doi.org/10.1093/aje/kwt133>



Hospitalizations across the US

Hospitalization rates remain low in VA but rapid change is possible as seen in other states

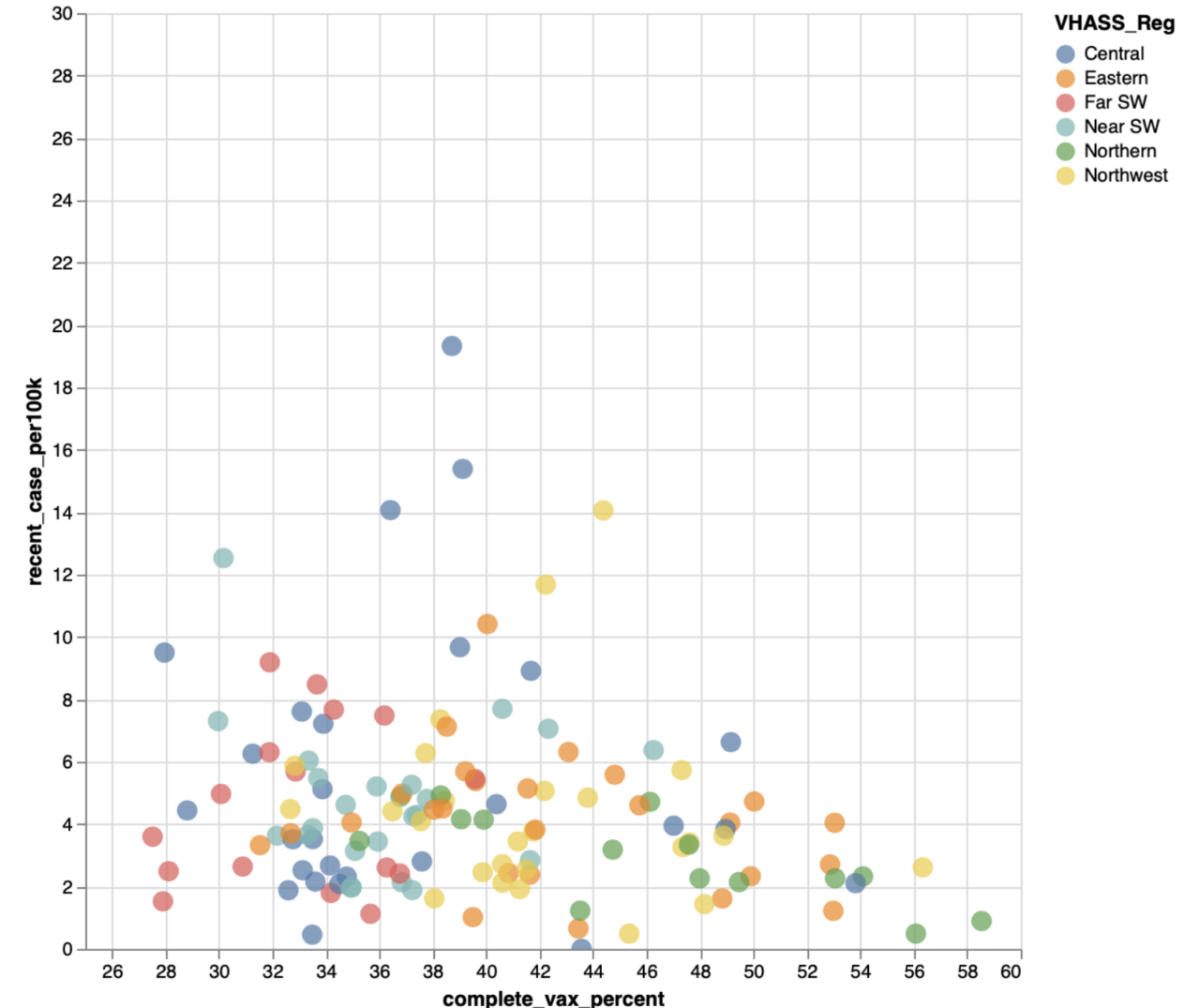
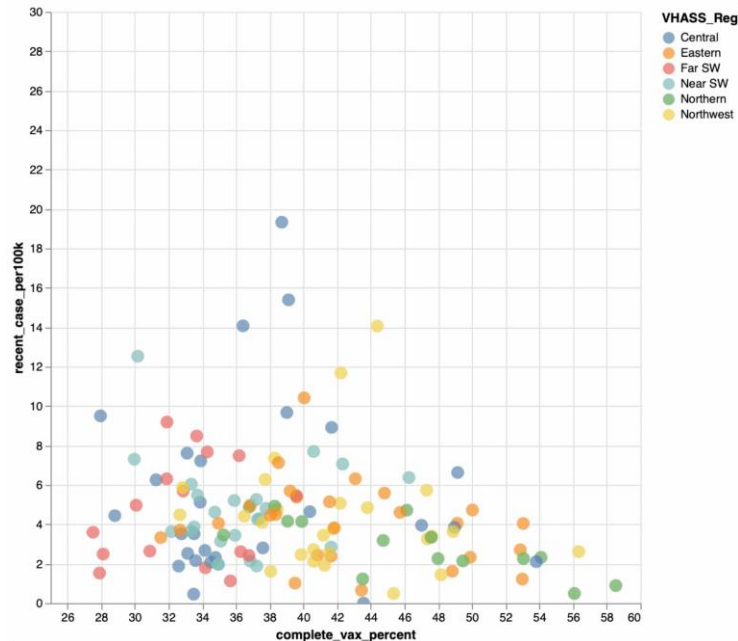
- Hotspot states see rapid rise in hospitalizations especially among the younger age groups



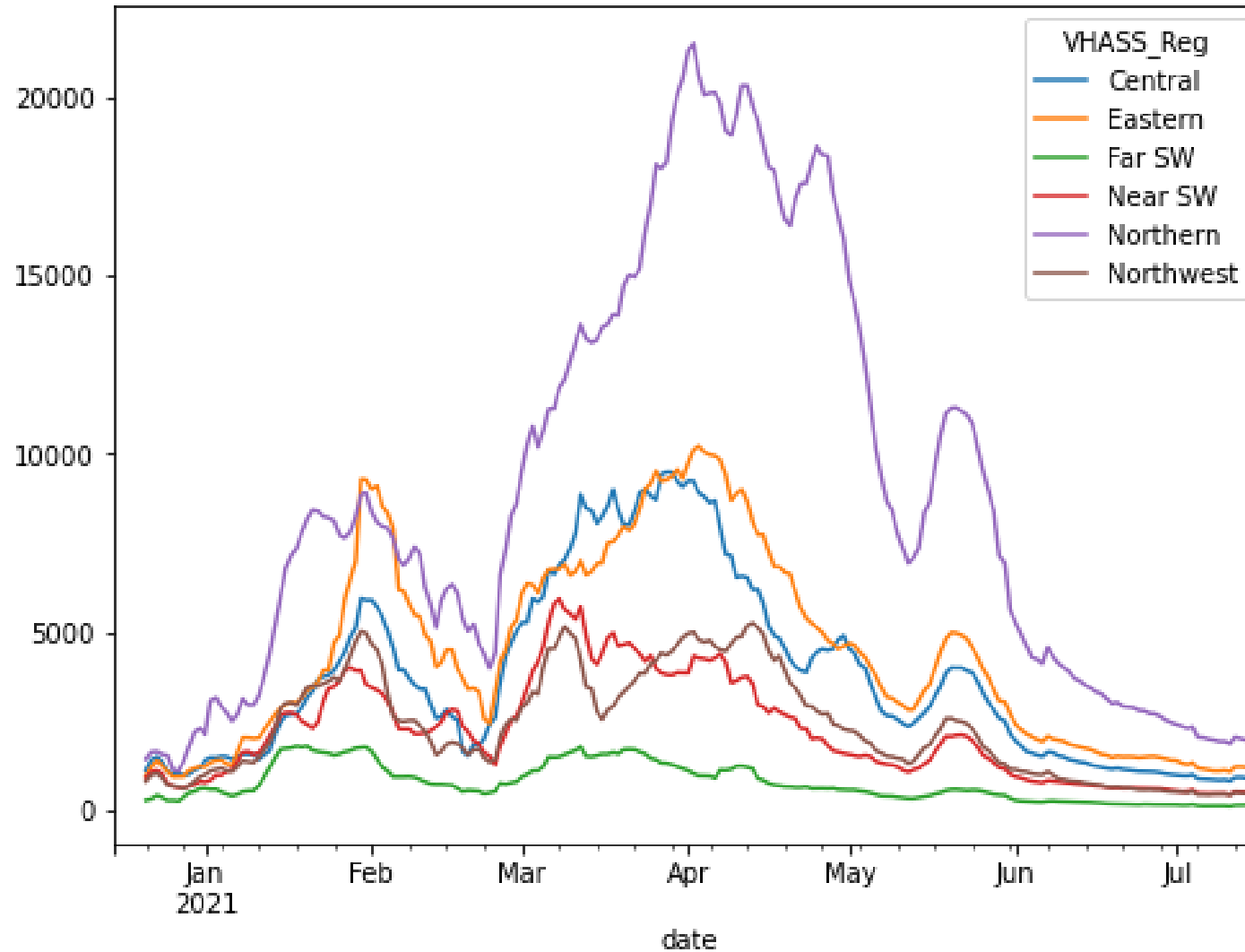
Recent case rate and Vaccination coverage

Vaccination coverage vs. recent case rate (per 100k) shows some correlation

- Most vaccinated currently remain at low levels, below 50% vaccinated has much more diversity
- Central and Near SW have highest case rates
- Interactive plot allows for further exploration

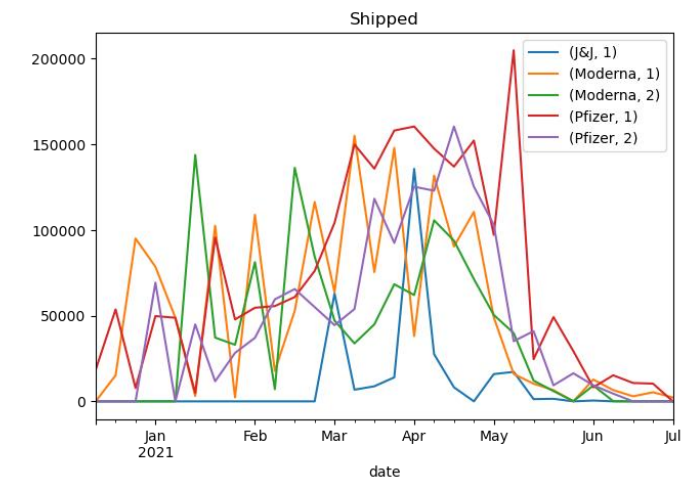


Vaccination Administration Slows



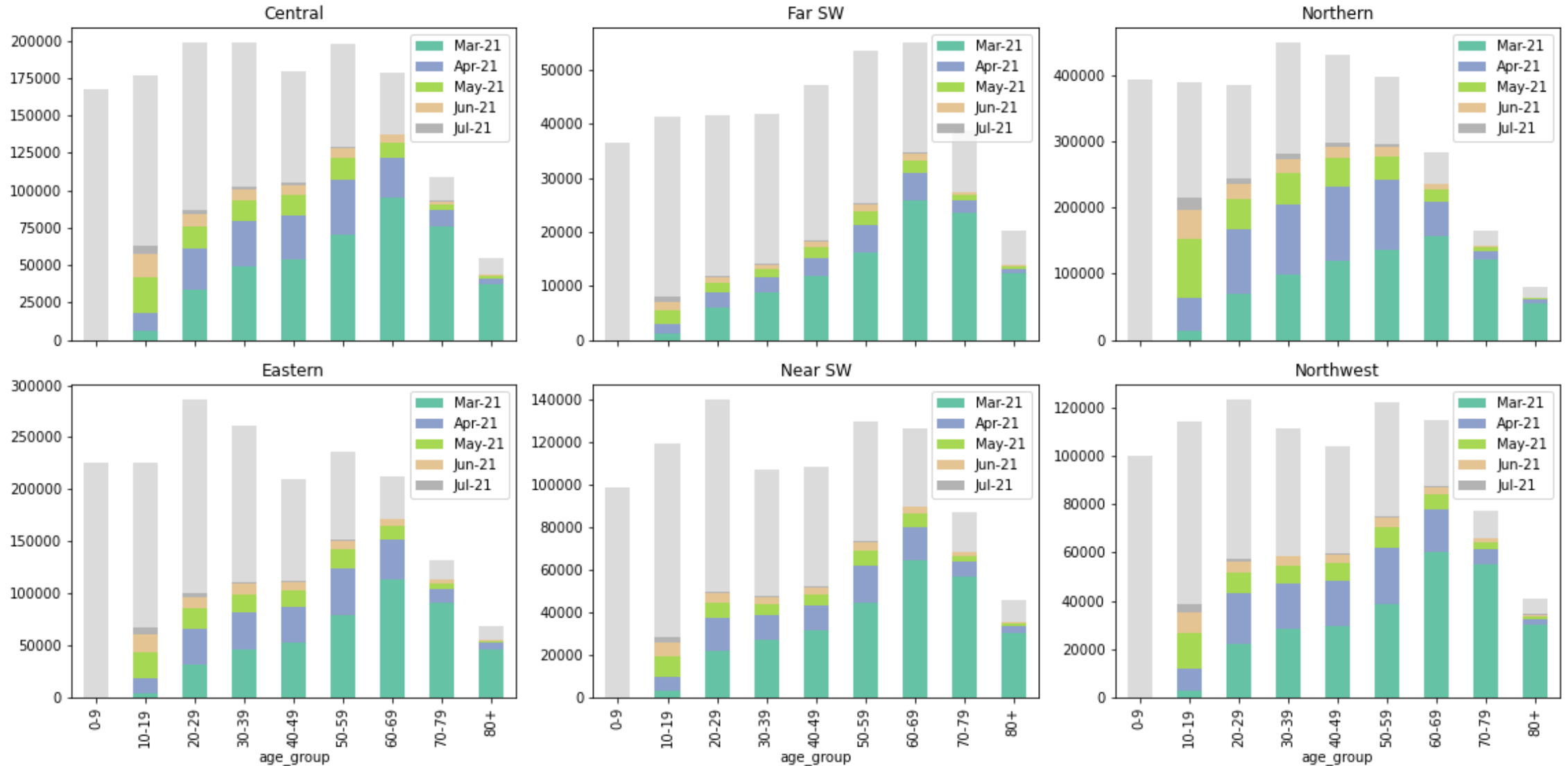
Regional Vaccine courses initiated per day:

- Total counts of first dose of vaccines across regions

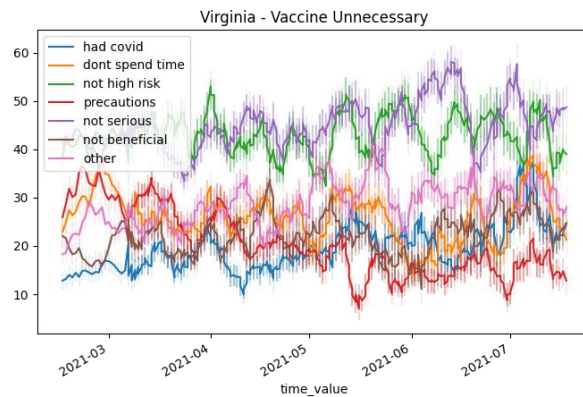
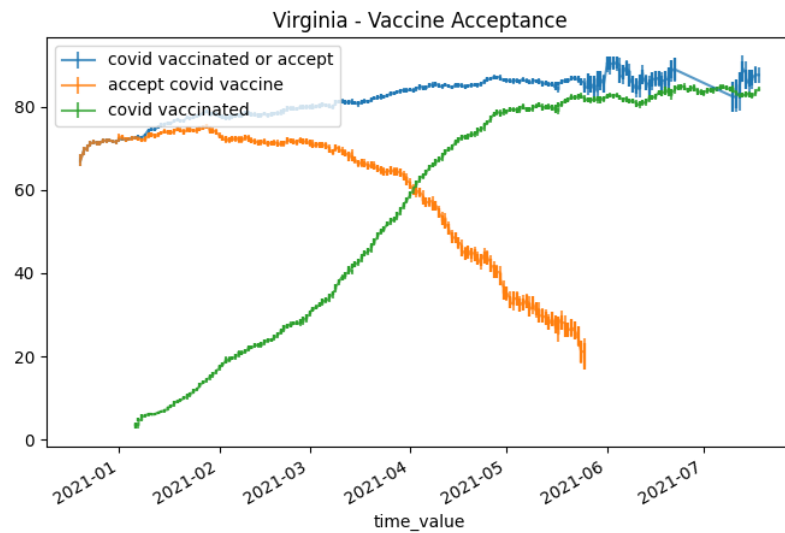


Shipments have slowed with decreased demand

Vaccinations Shift to Younger Populations

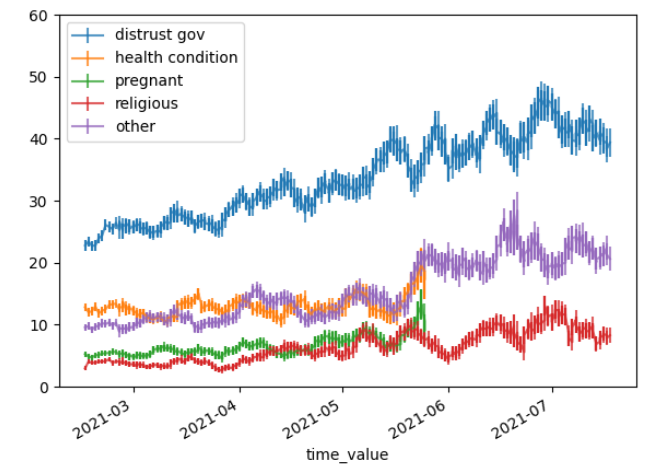
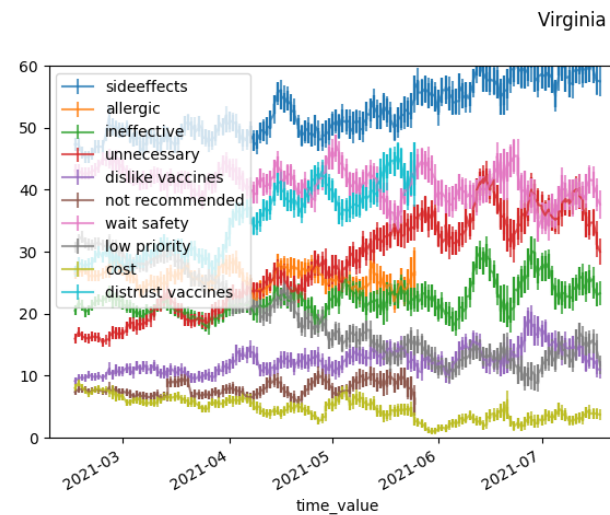


Vaccine Acceptance in Virginia - COVIDcast



Acceptance remains high:

- Proportion of Virginians that have already or would definitely or probably accept vaccination if offered today
- *Survey respondents are reporting high levels of vaccination of ~80% reflecting bias of the mechanism*
- **Top reasons for hesitancy:** side effects, distrust (increasing), unnecessary (increasing)
- **More likely to take if recommended by:** doctors and friends
- **Reasons unnecessary:** Not serious, not high risk, or other



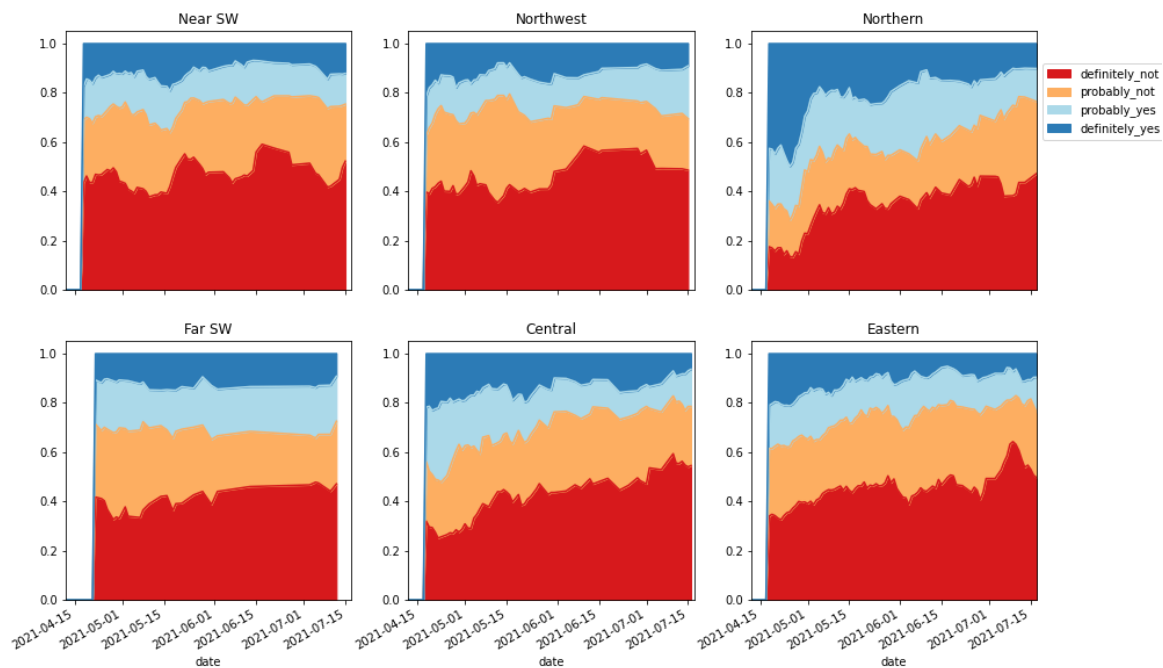
Data Source: <https://covidcast.cmu.edu>

Vaccine Acceptance by Region- COVIDcast

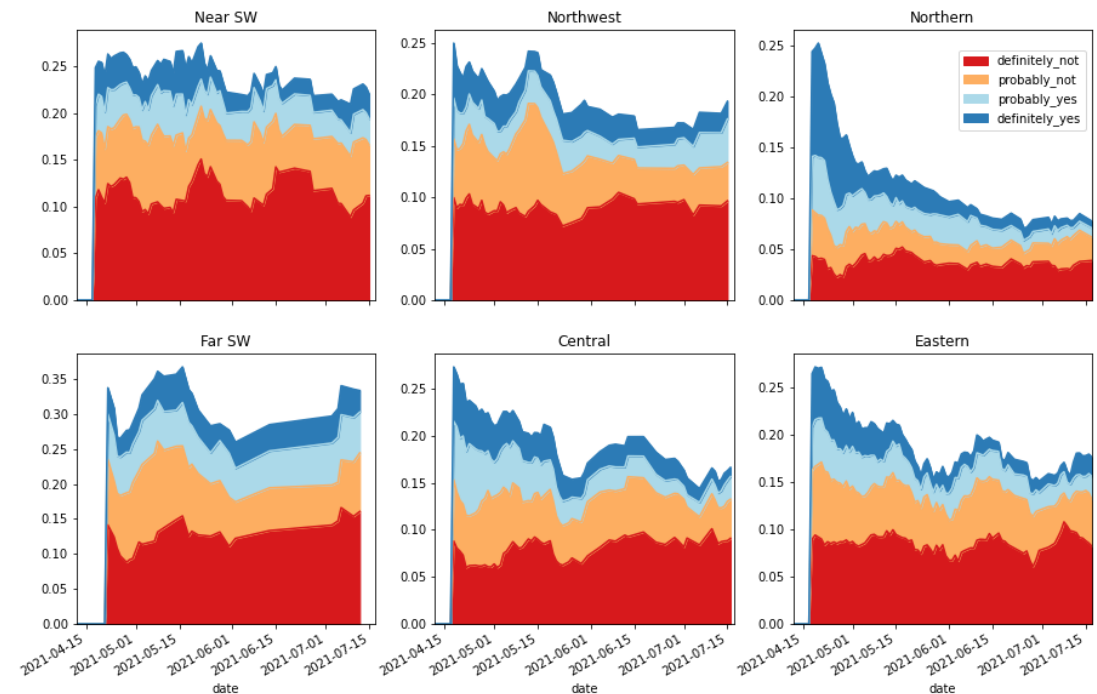
Levels of Acceptance and potential acceptance in flux:

- Nearly all the “Definitely Yes” have been vaccinated, yet there are 5-10% remaining across the regions
- Northwest and Southwest (to lesser degree) see growth in “probably not”, seemingly from “definitely not”

Unvaccinated Only



All Respondents



Data Source: <https://covidcast.cmu.edu>

23-Jul-21



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SARS-CoV2 Variants of Concern

Delta δ - Lineage B.1.617.2 and related subvariants

- Delta plus $\delta+$ lineage which contains the K417N mutation is emerging as a sub-variant that is even more transmissible. Declared a VoC in India
- Strain shows [continued growth in Europe](#) and across US, predicted to predominate in coming weeks (July 2nd in VA), Scotland now experiencing highest daily case counts, driven by delta.
- [Several studies](#) estimate B.1.617.2 to have 100% faster growth than B.1.1.7, and a UK study suggests a 13% advantage over B.1.1.7; we are roughly tracking what seems to be a ~60% growth rate advantage in VA
- [More studies](#) show limited [immune escape](#) similar to B.1.351, however, many studies still suggest protection remains for vaccinated, especially 2 doses and mRNA vaccines
- [PHE study](#) shows limited efficacy of Astra-Zeneca with only one dose, efficacy returns following 2nd dose, [also stronger with a followup Pfizer](#)
- [Public Health Scotland study in Lancet](#) suggests Delta is 2x more likely to cause hospitalization than Alpha
- [New study](#) shows evasion of natural and of Pfizer vax (though weak) also shows transmissibility boost comes from more efficient fusion and lung cell entry

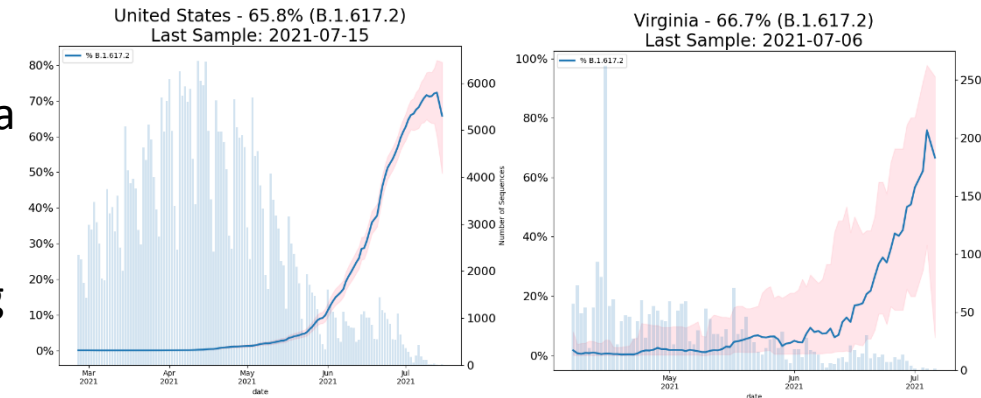
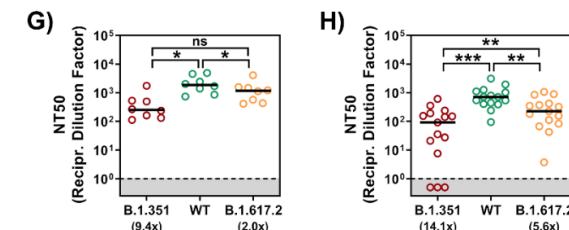


Table 1: Estimated vaccine effectiveness against hospitalisation

Vaccination status	Alpha			Delta		
	OR vs symptomatic disease	HR vs hospitalisation	VE vs hospitalisation	OR vs symptomatic disease	HR vs hospitalisation	VE vs hospitalisation
Any vaccine						
Dose 1	0.51 (0.48-0.55)	0.44 (0.28-0.70)	78% (65-86)	0.69 (0.64-0.75)	0.37 (0.22-0.63)	75% (57-85)
Dose 2	0.13 (0.1-0.15)	0.64 (0.24-1.72)	92% (78-97)	0.20 (0.18-0.23)	0.29 (0.11-0.72)	94% (85-98)
Pfizer						
Dose 1	0.53 (0.47-0.58)	0.32 (0.14-0.73)	83% (62-93)	0.64 (0.54-0.77)	0.10 (0.01-0.76)	94% (46-99)
Dose 2	0.06 (0.05-0.08)	0.88 (0.21-3.77)	95% (78-99)	0.12 (0.1-0.15)	0.34 (0.10-1.18)	96% (86-99)
Astrazeneca						
Dose 1	0.51 (0.48-0.55)	0.48 (0.30-0.77)	76% (61-85)	0.70 (0.65-0.76)	0.41 (0.24-0.70)	71% (51-83)
Dose 2	0.26 (0.21-0.32)	0.53 (0.15-1.80)	86% (53-96)	0.33 (0.28-0.39)	0.25 (0.08-0.78)	92% (75-97)

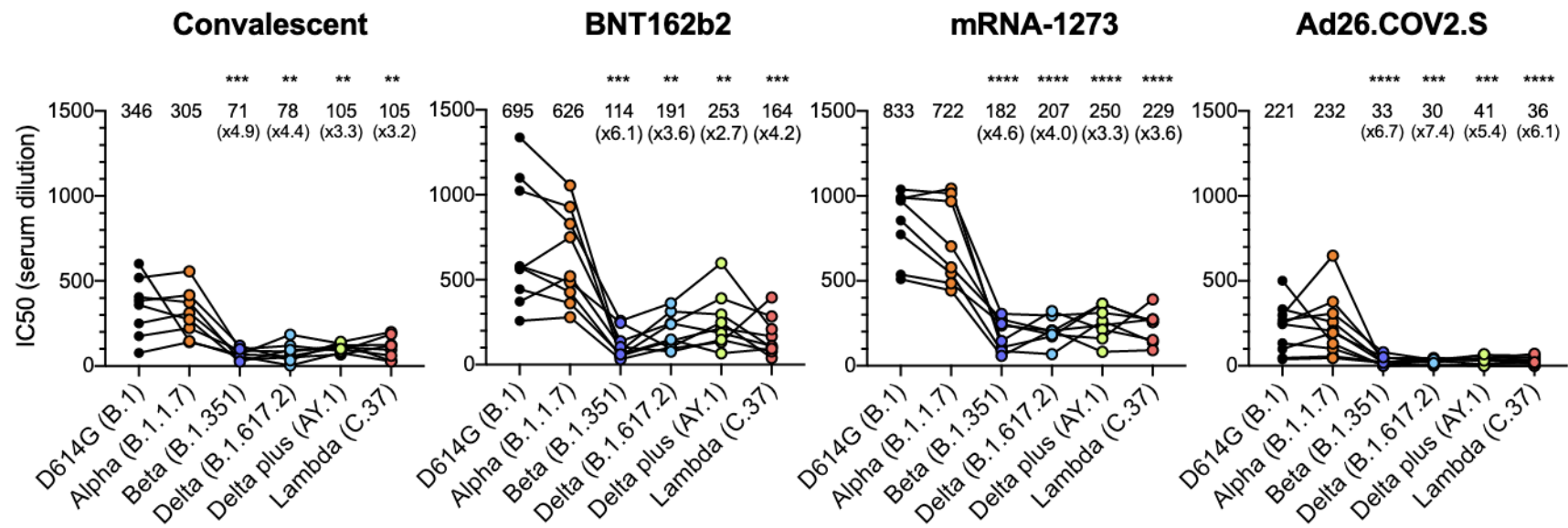
Public Health England study shows vaccines are effective against hospitalization with Delta variant infections (94-96% for Pfizer). Also shows that one dose AZ has much lower efficacy (71%) [PHE](#)



We show,, that B.1.617.2 evades control by antibodies induced upon infection and and even Pfizer's vaccine, although with lower efficiency as compared to B.1.351, as well as a common monoclonal treatment. Finally, we show increased Calu-3 lung cell entry and enhanced cell-to-cell fusion of B.1.617.2, which may contribute to augmented transmissibility and pathogenicity of this variant.

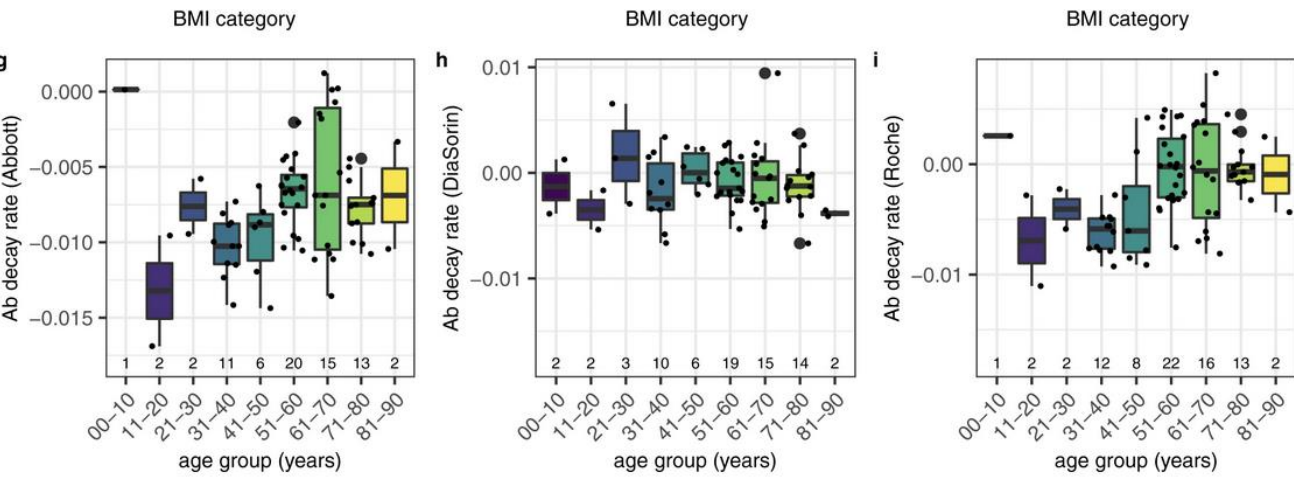
[BioRxiv](#)

B

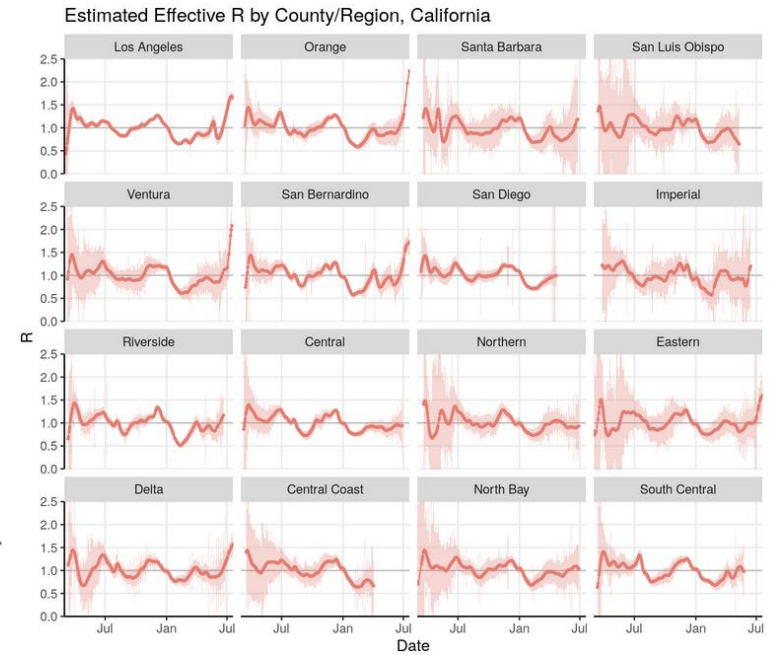


BNT162b2 and mRNA-1273-elicited antibodies showed modest neutralization resistance against Beta, Delta, Delta plus and Lambda variants whereas Ad26.COV2.S-elicited antibodies from a significant fraction of vaccinated individuals were of low neutralizing titer (IC50<50)

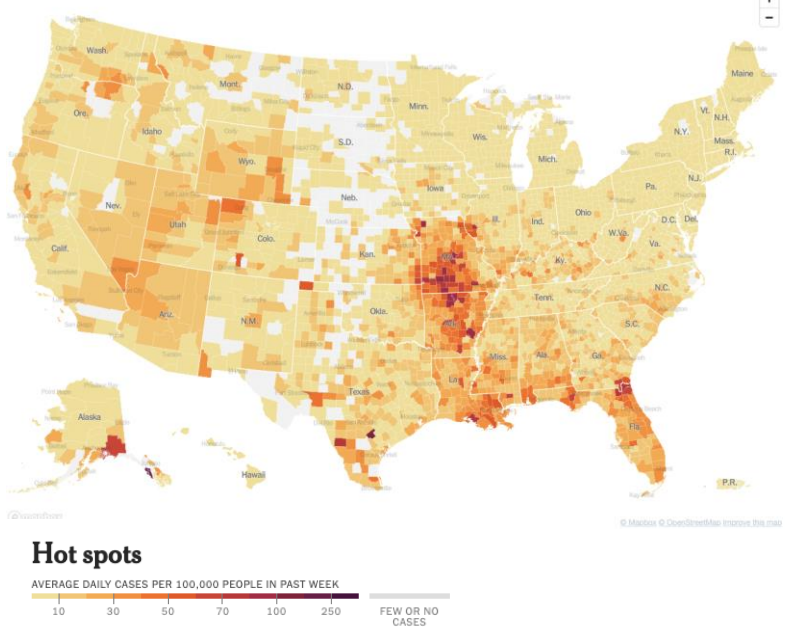
<https://www.biorxiv.org/content/10.1101/2021.07.19.452771v1.full.pdf>
<https://www.nytimes.com/2021/07/20/health/coronavirus-johnson-vaccine-delta.html>



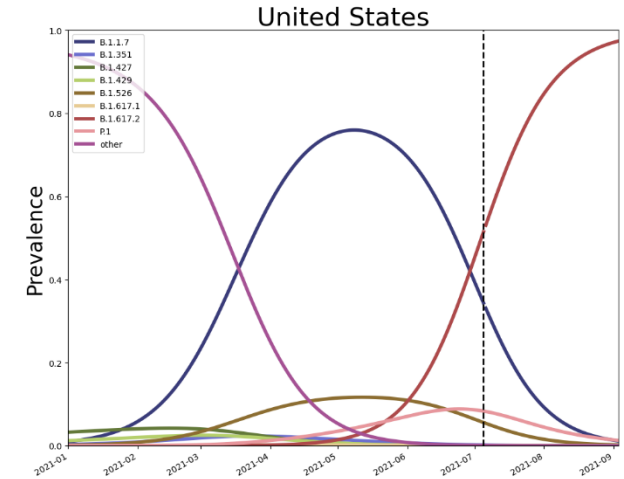
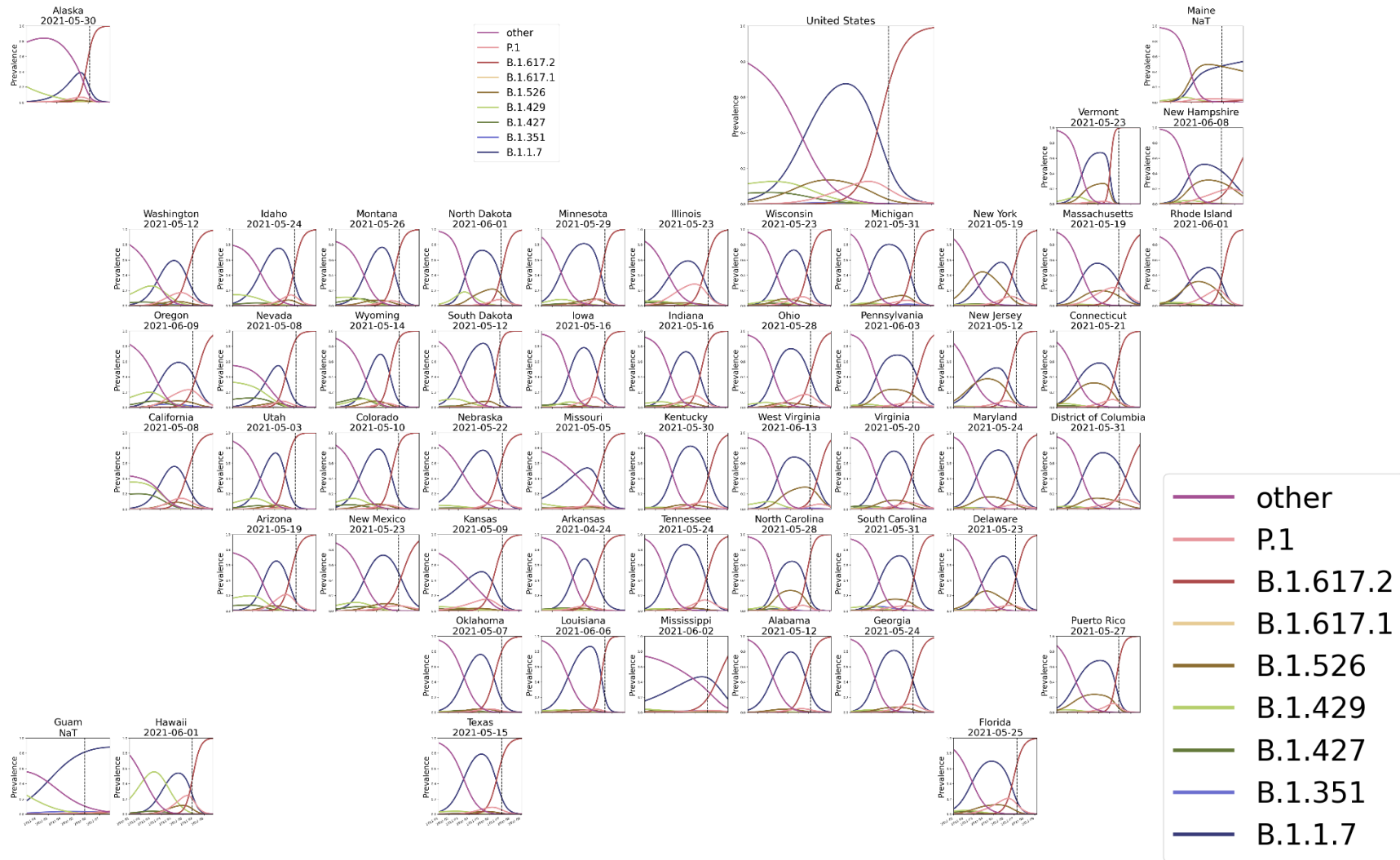
Study of serosurvey from Vo Italy, shows estimated antibody decay rate after 9 months
<https://www.nature.com/articles/s41467-021-24622-7>
<https://twitter.com/EricTopol/status/1417112854965018632>



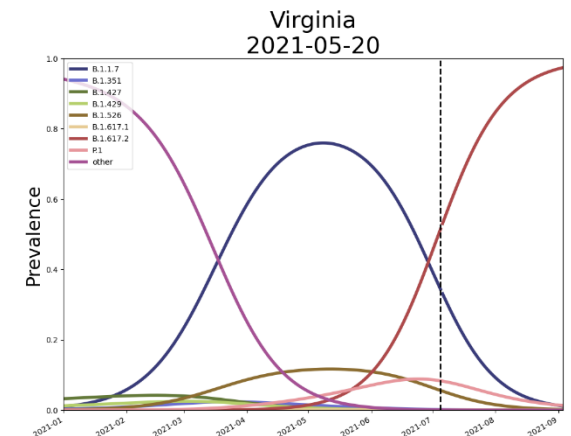
Substantial increases in estimated R effective in California counties <https://ca-covid-r.info/>



Variant of Concern Trajectories

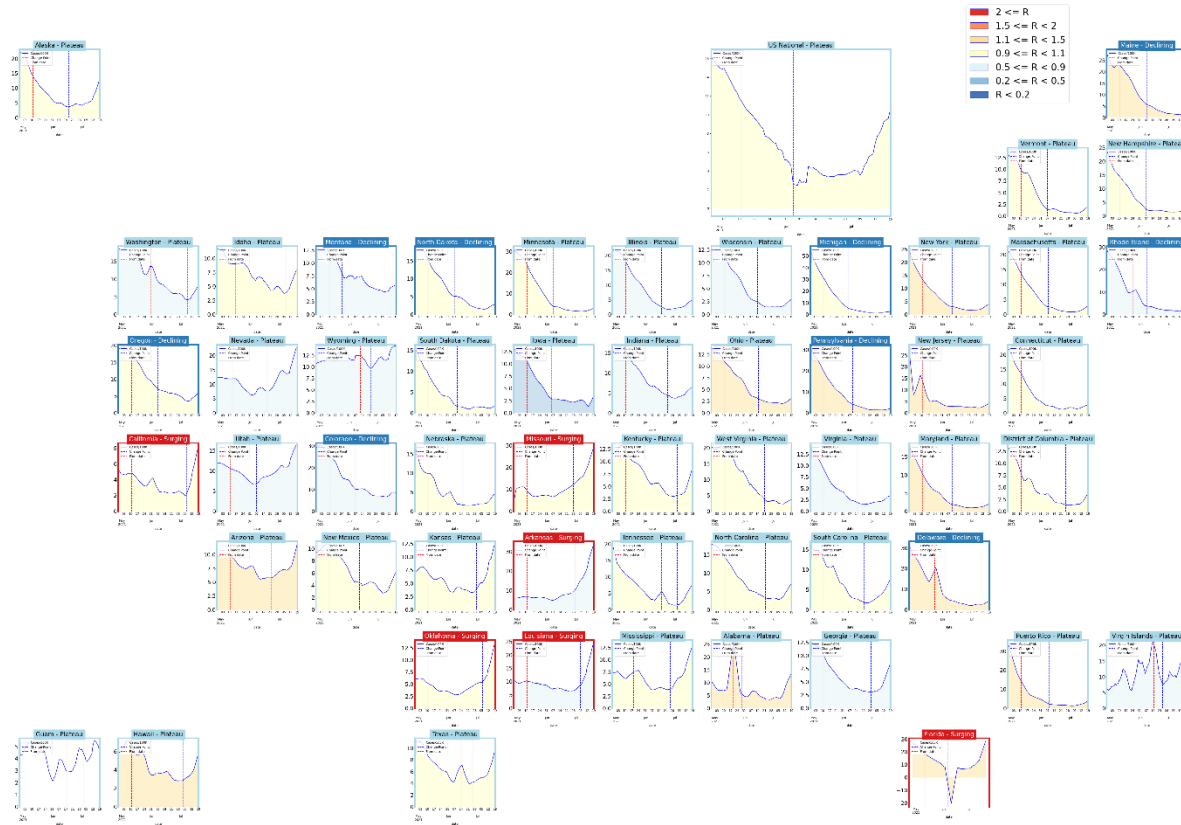


5% - May 21; 50% - July 2nd



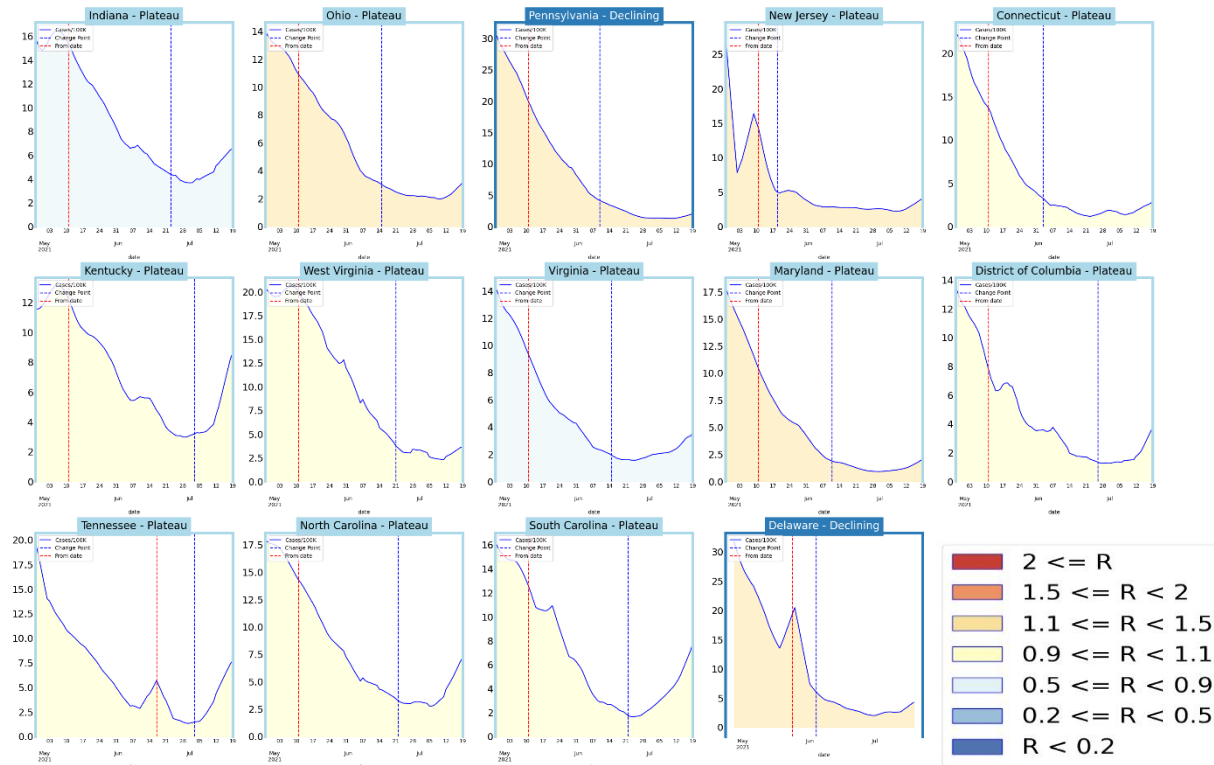
Other State Comparisons

Trajectories of States



- Lots of new growth with 6 states in surge and many others with upward trajectories.

Virginia and her neighbors



- VA and neighbors are all in plateau with moderate growth

References

Venkatramanan, S., et al. "Optimizing spatial allocation of seasonal influenza vaccine under temporal constraints." *PLoS Computational Biology* 15.9 (2019): e1007111.

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Virginia Department of Health. COVID-19 in Virginia. <http://www.vdh.virginia.gov/coronavirus/>

Biocomplexity Institute. COVID-19 Surveillance Dashboard. <https://nssac.bii.virginia.edu/covid-19/dashboard/>

Google. COVID-19 community mobility reports. <https://www.google.com/covid19/mobility/>

Biocomplexity page for data and other resources related to COVID-19: <https://covid19.biocomplexity.virginia.edu/>

Questions?

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